The Research Subcommittee of the Committee on Science of the United States House of Representative

Hearing on: “Nanotechnology: Where Does the U.S. Stand?”

Testimony of:

Sean Murdock

Executive Director

NanoBusiness Alliance

June 29th, 2005

10:00 a.m.

Rayburn Office Building

I would like to thank you, Mr. Chairman, Ranking Member Hooley, and Members of the House Research Subcommittee of the Committee on Science for the opportunity to testify on this critically strategic question.

My name is Sean Murdock, and I am the Executive Director of the NanoBusiness Alliance. The NanoBusiness Alliance is the premier nanotechnology policy and commercialization advocacy group in the United States. NanoBusiness Alliance members span multiple stakeholder groups and traditional industrial sectors, including newly formed start-ups surviving on angel funding or SBIR grants, Fortune 500 companies with multimillion dollar commitments to nanotechnology R&D, academic research institutions, and public-private partnerships working to derive economic development and growth through nanotechnology. This wide group of stakeholders has come together because we believe that nanotechnology will be one of the key drivers of business success, economic growth and quality-of-life improvements in the 21st century. The Alliance provides a collective voice and a vehicle for efforts to advance the benefits of nanotechnology across our economy and society.

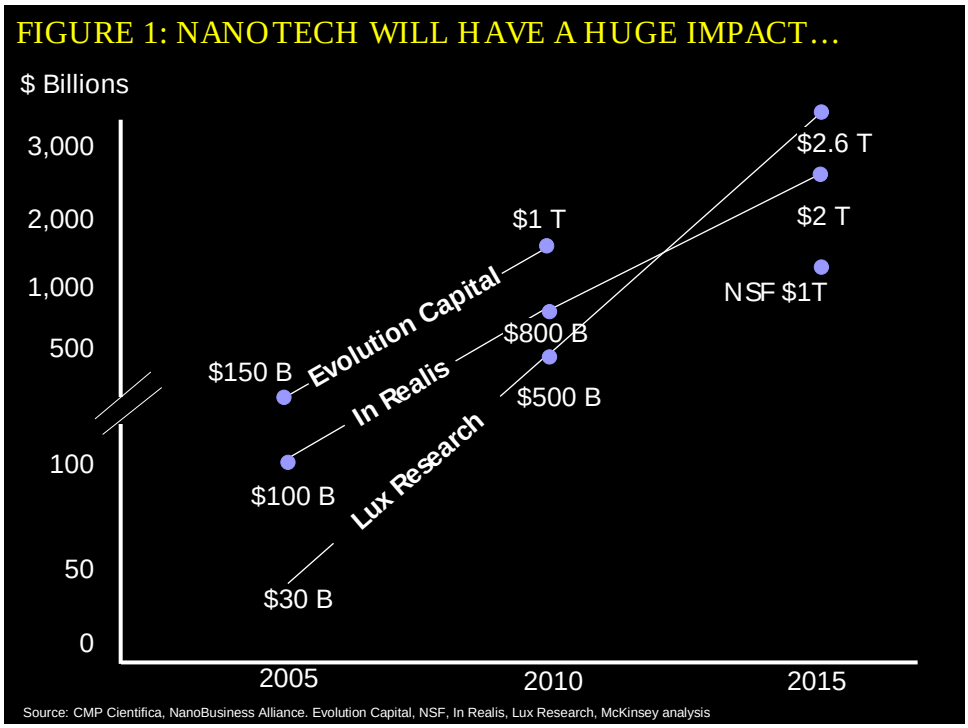
With that perspective in mind, I would like to share with you my thoughts on the United States' competitive position in both the research and commercialization of nanotechnology. The U.S. is leading the world in nanoscience today, but our lead is narrow and we face stiff and accelerating competition. Action, both in terms of spending and policy, is required at the Federal, State, and local levels to assure that we maintain this lead.

Since this subcommittee has relatively strong familiarity with nanotechnology and the 21st Century Nanotechnology Research & Development Act, I only need to give some highlights of the potential of nanotechnology and why it is so important. It is my belief and the belief of every member of the Alliance that nanotechnology will have a tremendous impact on virtually every sector of the global economy, a belief that is reflected in the diversity of our membership. In some industries, such as data storage, companies without a nanotechnology strategy already cannot compete. This will become pervasive in all industry sectors that produce goods rather than services. Furthermore, I believe that nanotechnology is not just a tremendous economic driver, but that its implications for homeland

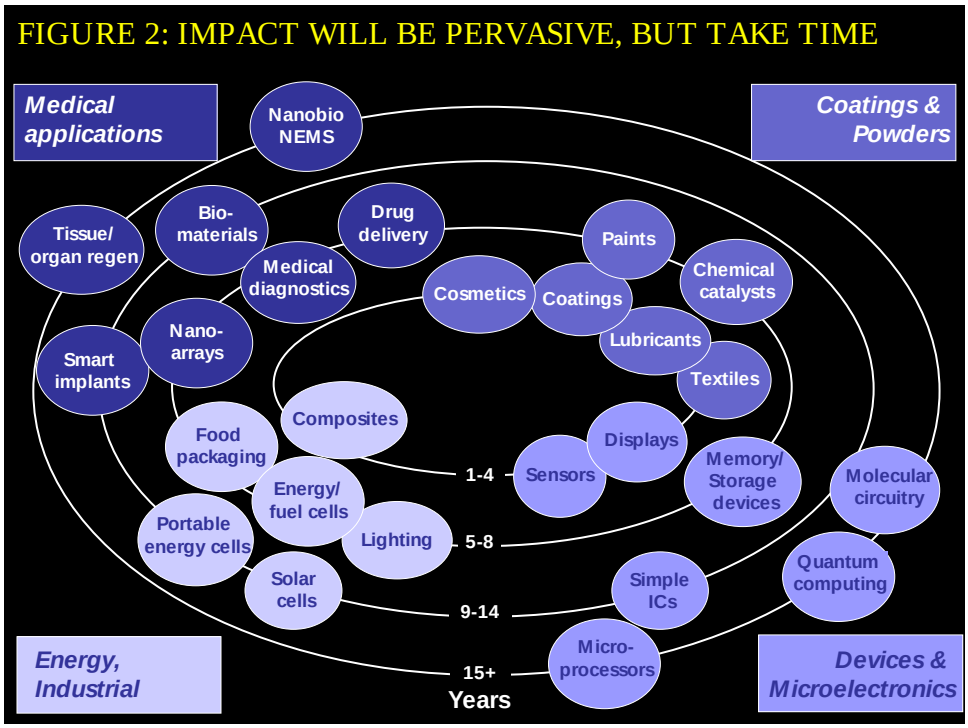
security, defense, cleaning the environment, and developing renewable, sustainable energy sources should make its development a key strategic as well as economic goal for the U.S. For these reasons, ***we as a nation and as the last superpower cannot afford to hold anything less than a commanding leadership position in the commercialization of nanotechnology.***

Investing in nanotechnology could also bring other benefits, beyond the creation of jobs, bolstering of the economy, and strategic leadership. Investing in commercialization allows us to reinvest in nanoscience education, research, and development, forging a virtuous circle that will ensure our children enjoy the same improvement in quality of life that we have. Nanotechnology's potential to provide solutions to the grand challenges of today could provide a rallying point and inspire interest comparable to the race to overtake Sputnik in the 50's and 60's, still one of the greatest periods of innovation in American history.

The stakes are incredibly high. The NSF has estimated that the global impact of nanotechnology enabled products and services will be $1 trillion by 2015. Many considered this estimate to be quite lofty when it was made in 2000 with the launch of the National Nanotechnology Initiative. However, more recent estimates for the global impact of nanotechnology enabled goods are even larger than the NSF's. In Realis, a consulting group, has predicted that nanotech will impact up to $2 trillion of global economic output, while Evolution Capital, an investment bank, estimates that the market will reach $1 trillion 5 years earlier in 2010. Finally, in perhaps the most rigorous study to date, Lux Research, a nanotechnology analyst group, has estimated that nanotech will impact $2.6 trillion in global economic output by 2015 (See Figure 1).



While these estimates are mind-numbingly large, a brief mention of some prospective applications and estimated time to market helps to make them more tangible and more credible. Simple and passive applications of nanotechnology including nanoparticles, coatings, catalysts, and nanocomposites are already on the market, while more revolutionary applications, including the first generation of nanotechnology-enabled pharmaceuticals, bulk nanomaterials, sensors, and many more are beyond the research stage and well into the product pipeline. In additional to developing revolutionary products, nanotechnology will radically change the cost-structures of many industries, making non-nano alternatives simply non-competitive. (See Figure #2).



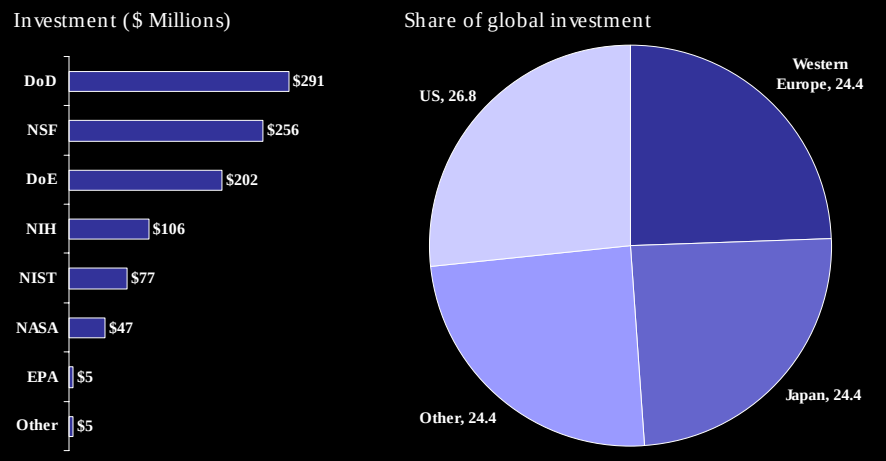
On the strategic side, nanotechnology will enable dramatic enhancements in military and homeland security capabilities. Start-ups are working on new protective armor, chem/bio suits, and chem/bio sensors, as well as a variety of technologies such as quantum computing and encryption which have enormous dual-use applications.

Given the potential of nanotechnology and the evidence of traction toward realizing that potential, it is increasingly clear that nanotechnology will be a game changing technology. Economists estimate that technology innovation in the U.S. (transistors, integrated circuits, recombinant DNA, etc) generated half of the economic growth over the past fifty years. ***Nanotechnology is likely to be the engine of innovation for the next fifty years, and we must be at the forefront of this innovation.***

That is the importance of nanotechnology as a national goal, but it does not answer the question of where the country currently stands with respect to other nanotechnology leaders such as China, Japan, and the E.U., the other global leaders in nanotech. Fortunately, at the current time, the U.S. is clearly in a leadership position, evidenced by its strength in investment, scientific publications, and patents. This should not be taken for granted – key innovations have been developed in the E.U. (such as the

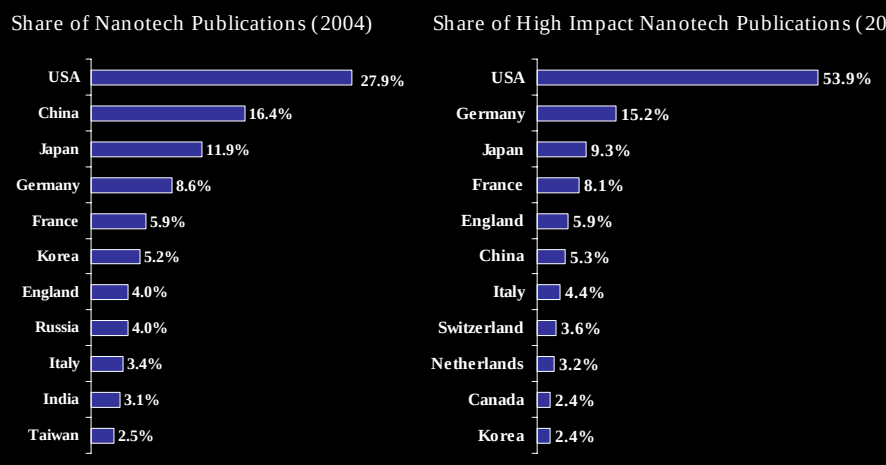
electron microscope, the instrument that helped enable all nanotech research) and Japan (such as the discovery of the nanotube, the most versatile and powerful nanomaterial yet developed).

FIGURE 3: THE U.S. CURRENTLYLEADS THE WORLD IN GOVERNMENT R&D INVESTMENT, WITH A LITTLE OVER 25% OF THE TOTAL



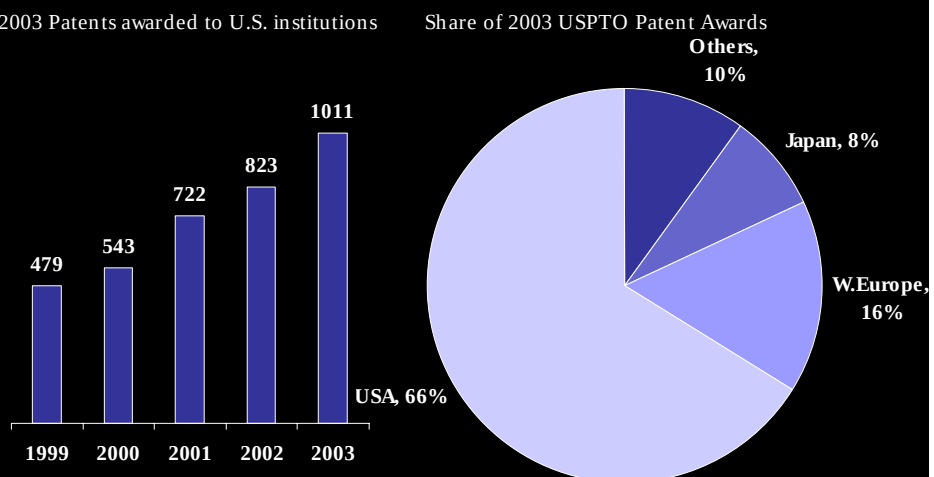
Source: Jim Murday, NanoBusiness Alliance Analysis

FIGURE 4: THE U.S. PUBLISHES MORE THAN ANYOTHER COUNTRYAND HAS A DISPROPORTIONATE SHARE OF HIGH IMPACT PAPERS



Source: Jim Murday, NanoBusiness Alliance Analysis

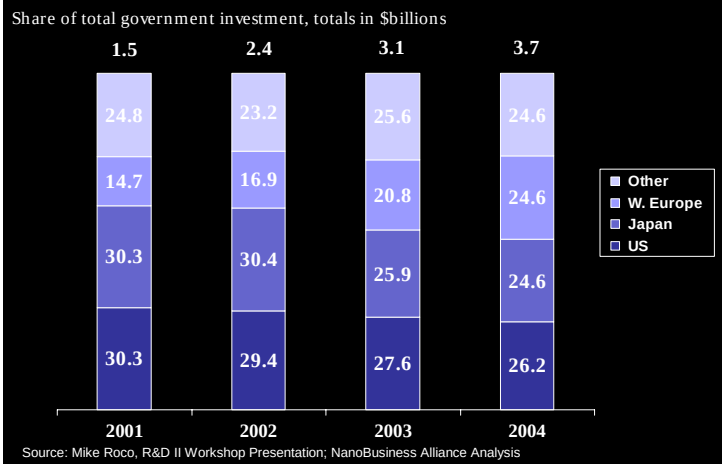
FIGURE 5: THE HIGH IMPACT RESEARCH IS LEADING A SURGE IN PATENT ACTIVITY, WITH THE U.S. MAINTAINING ITS SHARE OF U.S. PATENTS



Source: Jim Murday, Mike Roco, NanoBusiness Alliance Analysis

Ironically, the challenges to U.S. domination of nanotechnology are in part a result of our early support of nanotechnology. The formal launch of the NNI in 2000 brought the potential of nanotechnology into the world consciousness and initiated a race for global leadership. As a result, the U.S. share of global government expenditures has dropped since 2001, despite the absolute commitment more than doubling in the same time period from $465MM to $960MM (See Figure 6).

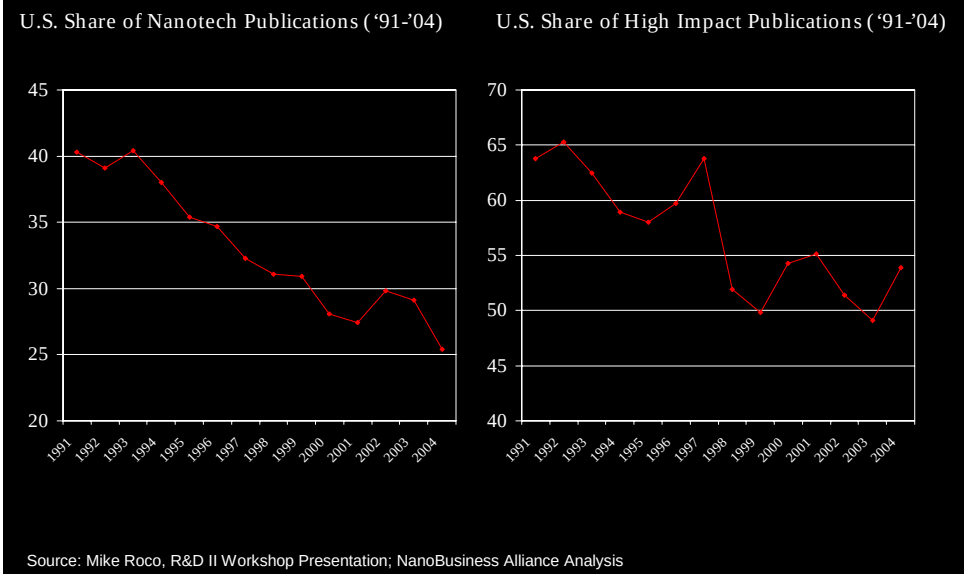
FIGURE 6: U.S. SHARE OF GLOBAL GOVERNMENT INVESTMENT IS DECLINING DESPITE SUBSTANTIAL ABSOLUTE GROWTH



Source: Mike Roco, R&D II Workshop Presentation; NanoBusiness Alliance Analysis

Not surprisingly, the growth in foreign investment in nanotechnology R&D has helped other nations to gain ground in the development of new knowledge, innovations and the production of human capital (See Figure 7).

FIGURE 7: U.S. SHARE OF PUBLICATIONS AND HIGH IMPACT PUBLICATIONS HAS ERODED SIGNIFICANTLYIN THE PAST DECADE



Source: Mike Roco, R&D II Workshop Presentation; NanoBusiness Alliance Analysis

Of particular competitive concern is China. The Scientist, an American academic journal, said that from January to August 2004 China had presented 3,621 research papers on nanotechnology, more than any other country, as tabulated by the Scientific Citation Index. According to the article, China published 14 percent more papers than the United States in that time period. Furthermore, China currently has more than 3,000 researchers who are engaged in related programs and has had series of innovative achievements according to the director of China's National Center for Nanoscience and Technology and the vice-president of the Chinese Academy of Sciences.

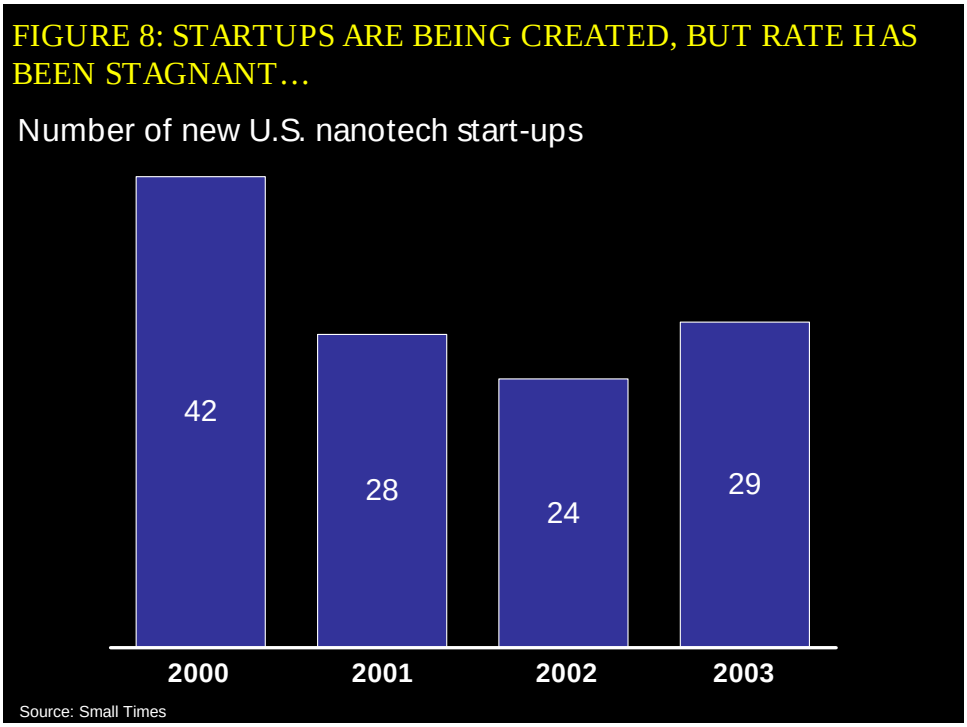
While knowledge development and nanoscience R&D create value, it is through the commercialization of nanotechnology into new processes and products that businesses will create jobs and nations will see a return on their investments.

According to the NanoBusiness Alliance's proprietary database on all companies involved with nanotechnology

worldwide, a little over 50% of the companies are in the United States (613 of 1175). However, if one is to believe the announcements made at the ChinaNano2005 trade expo that China has almost 800 companies involved with nanotechnology and a recent EU report claiming that Europe has 500, the share would appear to be significantly lower. Unfortunately, it is notoriously difficult to track commercial developments in nanotechnology, so we cannot be precisely sure.

However, the rate of formation of new nanotech start-ups over the past several years has been relatively stagnant (See Figure 8).

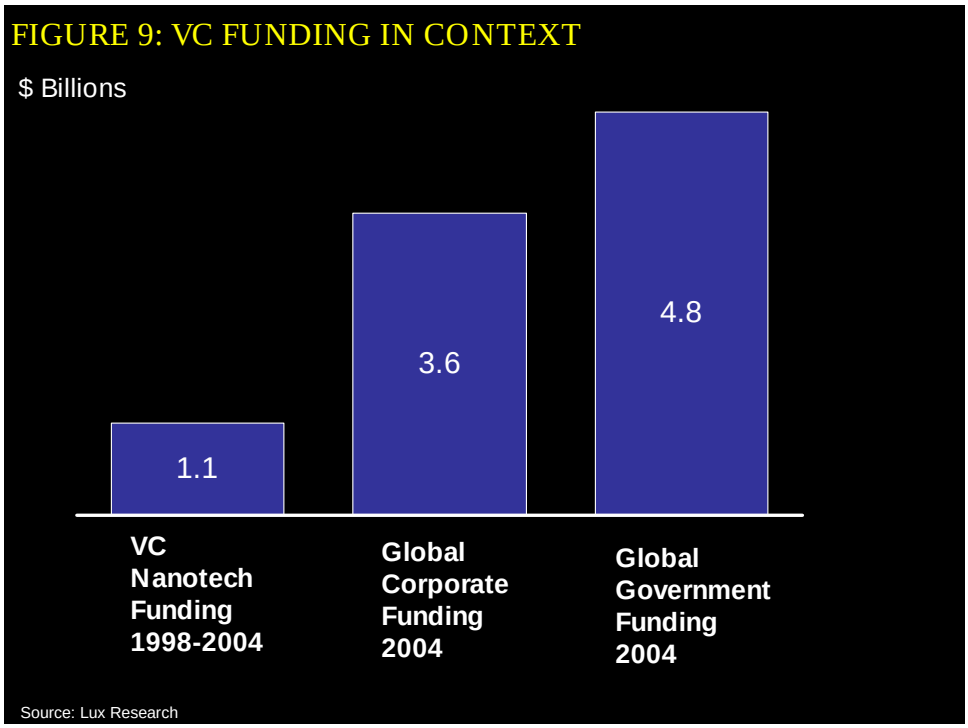
FIGURE 8: STARTUPS ARE BEING CREATED, BUT RATE HAS BEEN STAGNANT…



This is, perhaps, one of the most disconcerting indicators for nanotechnology in the U.S. The entrepreneurial culture and deployment of risk capital, especially venture capital, toward early stage technology companies has been a key source of competitive advantage for the United States. This historic advantage appears to be at risk.

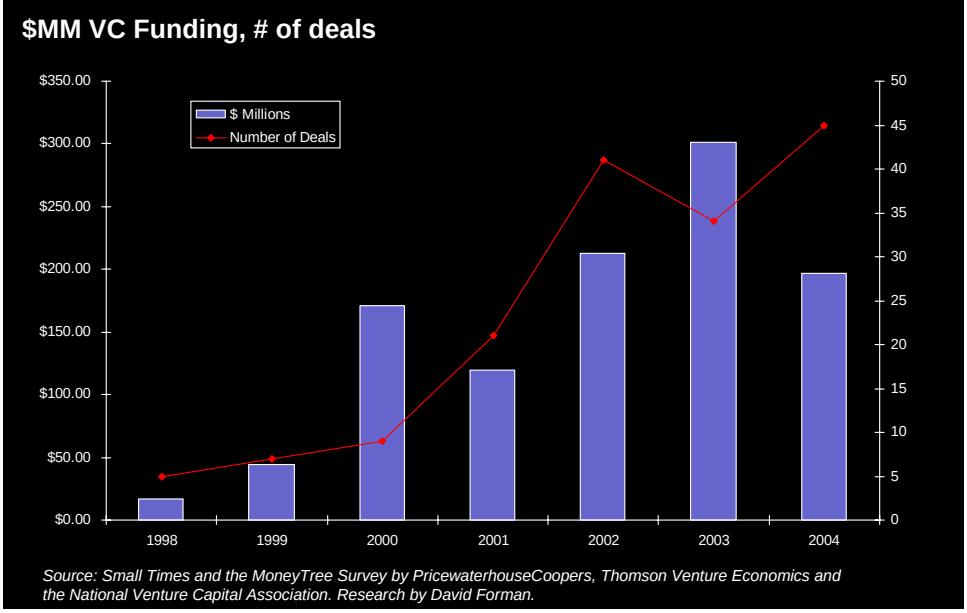
Although we lead in the number of nanotechnology startups, these startups need risk capital to bring these nanotechnology innovations to market. The so called “valley of death,” the period between a company’s formation and its

achieving significant cashflow, is particularly acute for nanotechnology. Most nanotech innovations require significant investment and "platform" development before any revenues can be generated because they are based upon fundamental breakthroughs in basic research at universities and federal labs. Burned by the dot com bubble and needing to raise IRR's in order to raise the next fund, VC's have been shying away from "platform" technologies without near term commercialization processes and end market economics. In fact, the total VC financing over the past seven years is approximately the same as the US government investment in 2004 (see Figure 9)



Furthermore, the investment to date has been highly concentrated in a few, mature nanotech companies.

FIGURE 10: VENTURE CAPITAL INVESMENT IN NANOTECH IS LIMITED AND CONCENTRATED



Highlighting this trend, almost all of the venture capital that went to nanotech companies in the first quarter of 2005 was placed into 4 companies, NanoTex ($33 MM), Nanomix ($17 MM), Nantero ($17 MM), and NanoOpto ($12MM).

While leading Fortune 500 companies have nanotechnology initiatives and some funding for R&D, most have scaled back their early stage research and development in response to stock market pressure for near term profitability and reducing costs. Many companies plan to "innovate through acquisition," relying upon start-ups to develop and commercialize innovations. This further expands the "valley of death" since companies are looking for startups to have developed their technologies far enough for ease of integration. It also means that more than ever start-ups represent the product pipeline for large corporations, and that their successful formation is key not only to creating new prosperity, but continuing our existing prosperity.

Until the VC cycle changes again and the stock markets allow companies to adopt longer time horizons, we have a substantial and growing "valley of death." Since the market is not prepared to take on this risk, the government needs to develop programs to bridge this gulf.

Given the current landscape, there are a few key initiatives that the Federal government can take to revitalize nanotechnology commercialization here and bolster our global lead.

The Federal investment in infrastructure and user facilities is part of the solution. These facilities, in theory, provide access to critical and expensive equipment, and reduce the capital intensity of nanotech commercialization activity. However, many nanotech start-ups lack the process knowledge and internal capabilities to make effective use of these investments. The government must also ensure sufficient operating funds to provide services and train the start-ups, or the assets will be underutilized and the investment will not generate the return we expect.

The U.S. government must be the "gold standard" as the most hospitable climate for commercializing nanotech innovations. We must lead in the development of new nanotech knowledge and research infrastructure. As such, our share of worldwide government investment should be at least on par with our share of global GDP.

We should establish goal-oriented research programs to address our grand challenges. While much fundamental research remains to be done, we should endeavor to do it to the extent possible within the context of its potential uses. The National Cancer Institute's Centers for Cancer Nanotechnology Excellence (CCNEs) provide a model for this. To quote the recent solicitation, "The CCNEs will be a national resource that will integrate nanotechnology development into basic and applied cancer research to facilitate the rapid application of this science in the clinic. This initiative will catalyze targeted discovery and development efforts that offer the greatest opportunity for advances in the near and medium terms and will lower the barriers for those advances to be translated to the private sector for commercial development." The NCI has established clear objectives without constraining how to get achieve them, and thus the creativity of the scientists pursuing the research. This model should be emulated and extended in other agencies and strategic investment areas.

Next, the government must fully and effectively utilize the SBIR and ATP programs to enhance commercialization activity. Many member companies speak of the "myth" of the SBIR Phase III – the phase where innovations proved out in Phase II are

supposed to be brought into use in the sponsoring agency. While the SBIR grants in and of themselves are quite valuable to those attempting to commercialize nanotech innovations, purchases to meet agency needs would generate a sustainable source of revenues and provide customer validation. Furthermore, this would ensure that our agencies, particularly Defense and Homeland Security, remain ahead of the world in terms of nanotech integration capabilities.

The ATP program, although controversial, provides one of the only sources of capital (and thus incentives) for new nanotech innovation ecosystems to form, particularly between U.S. startups and incumbents. If we are to retain jobs in our existing companies and industries, then we will need to integrate the innovations of nanotech start-ups into these sectors rapidly. Without incentives to form domestic partnerships, the value from our nation's investment may be disproportionately captured by foreign companies and governments with patient capital who partner with cash strapped U.S. startups.

However much the government can do directly, in the end, the greatest leverage will be achieved by creating stronger incentives for the private sector to invest and aggressively participate in the commercialization process. To that end, we should investigate establishing a permanent R&D tax credit and possibly create new vehicles like the R&D Limited Partnerships that were instrumental in biotech capital formation. These will unlock not only more of the potential of nanotech, but of all technology-driven industries.

In closing, all technological progress depends first and foremost upon human capital. We must adopt an integrated human capital strategy spanning multiple time horizons. In the near term, we must encourage the best and brightest to come to the U.S., help build out our knowledge base, and transform nanotech inventions to innovations that touch our daily lives. This will mean streamlining immigration requirements for "knowledge" and highly skilled workers so that we not only attract but retain these workers as citizens. In the medium term, we must greatly strengthen our job training programs. In the longer term, we must dramatically strengthen the science and technology education system, the ultimate investment in our commercial future.